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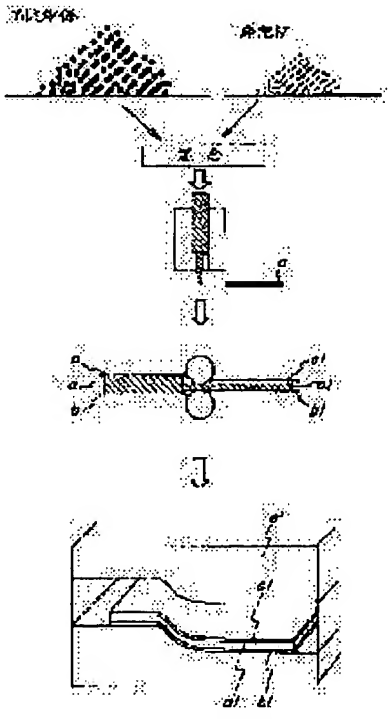
(54) PRODUCTION OF CURVED SURFACE SANDWICH PANEL

(57)Abstract:



PROBLEM TO BE SOLVED: To produce a curved surface sandwich panel accurately by a method in which a laminated material is obtained by pressing a member in which a thick metal foaming material is placed between two face plates in a prescribed curved surface shape, the laminated material is arranged in a mold formed in a product shape, pressurized, and molded by the foaming of a foaming agent.

SOLUTION: In the production of a curved surface sandwich panel, a metal powder (aluminum powder, etc.), and a foaming material (TiH2 powder, etc.), after being mixed, are extruded in to a plate to produce a member before foaming (a) as a core material. Next, the member (a) is inserted between aluminum plates (b), (c) and pressed by press rolls to mold a laminated plate. Next, the end part of the laminated plate is engaged with an extruding mold material, the member (a), after being sealed completely, is set in a foaming mold for obtaining a desired product shape, the mold is clamped with an extrusion shape and induction-heated in such a state to expand the foaming material, and the sandwich panel having a shape in accordance with the mold of a product shape surface is obtained.

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TITLE: Curved sandwich panel manufacturing method involves forming laminate using metal powder and foaming agent between two face plates followed by molding and stamping process

PATENT-ASSIGNEE: NISSAN MOTOR CO LTD[NSMO]

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ABSTRACTED-PUB-NO: JP2000168021A

BASIC-ABSTRACT:

NOVELTY - The foaming agent and metal powder are arranged between a pair of perforated face plates (b1,c1) and a rolling plating is performed to obtain a laminated material. The laminated material is then shaped in a metallic mold (e) to a desired shape followed by press stamping for air tight sealing of edge portions.

USE - For manufacturing curved sandwich panels.

ADVANTAGE - Increases productivity by reducing number of processes. Panels with desired shape and favorable quality are obtained due to use of foaming material.

DESCRIPTION OF DRAWING(S) - The figure shows the explanatory diagram of the curved sandwich manufacturing method.

Face plate b1,c1

Mold e

CHOSEN-DRAWING: Dwg.2/3

TITLE-TERMS: CURVE SANDWICH PANEL MANUFACTURE METHOD FORMING LAMINATE METAL POWDER FOAM AGENT TWO FACE PLATE FOLLOW STAMP PROCESS

DERWENT-CLASS: M22 P53 P73

CPI-CODES: M22-H03F;

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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] In manufacture of the curved-surface sandwiches panel which consists of a face-plate [of both the outsides of the porous layer by which foaming formation was carried out as core material, and this porous layer] of two sheets of solid metal As primary processing, a metal powder and a foaming agent are put between the face-plates of solid metal of two sheets. Rolling plaiting is given to the obtained member, press working of sheet metal is performed for the member in which each class carried out metallic bond by this to a predetermined curved-surface configuration or a predetermined three-dimension configuration, and a laminated wood is obtained. After that as secondary elaboration The manufacture approach of the curved-surface sandwiches panel characterized by having sealed all panel edges in case a foaming agent is made to foam and is fabricated by arranging a product configuration in ******** metal mold, and pressurizing the laminated wood by which press working of sheet metal was carried out.
[Claim 2] The manufacture approach of the curved-surface sandwiches panel characterized by sealing a panel edge by clamping a panel edge in the manufacture approach of a curved-surface sandwiches panel according to claim 1.
[Claim 3] The manufacture approach of the curved-surface sandwiches panel characterized by sealing a panel edge by welding extrusion material to a panel edge in the manufacture approach of a curved-surface sandwiches panel according to claim 1.
[Claim 4] claims 1-3 -- the manufacture approach of the curved-surface sandwiches panel characterized by changing the thickness of the mixolimnion of a metal powder and a foaming agent by controlling the welding pressure of rolling plaiting in the manufacture approach of a curved-surface sandwiches panel given [one of] in a term.
[Claim 5] claims 1-4 -- the manufacture approach of the curved-surface sandwiches panel characterized by changing the thickness of the mixolimnion after foaming by changing the foaming agent mixing percentage to a metal powder in the manufacture approach of a curved-surface sandwiches panel given [one of] in a term.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the manufacture approach of a curved-surface sandwiches panel of having the porous layer by which foaming formation was carried out at core material, about the manufacture approach of a curved-surface sandwiches panel.
[0002]
[Description of the Prior Art] The approach as typically shown in drawing 1 as the shaping approach of a curved-surface foaming sandwiches panel from the former is used. This approach mixes an aluminium powder object and foaming agent fine particles first, carries out extrusion molding of these mixed fine particles, fabricates them for the material a in alignment with the configuration equivalent to the core section of a product panel, pinches this material a with the aluminum plates b and c, and fabricates this with a roll to the plate of one. Subsequently, after preforming with a press the plate concerned which consists of face-plates b1 and c1 and a core a1 (the lowest style Fig. in drawing 1), by putting into the foaming mold for obtaining a product configuration, applying heat, and making a core a1 foam, it is the approach of making a face-plate the configuration where the mold configuration was met, and a curved-surface foaming sandwiches panel is manufactured.
[0003] However, if it was in the shaping approach of such a conventional curved-surface foaming sandwiches panel, since the foaming itself was natural foaming, the face-plate pantograph adherence pressure by foaming was small, and in order to make a face-plate into the configuration where the product curved surface was met, there was constraint that the face-plate itself had to be made into the shape of a thin film which may deform by the small shaping force. Moreover, since a face-plate was a thin film-like, when the face-plate was prolonged for a while or received local deformation from this constraint, there was a problem of fracturing. It was difficult to manufacture what has a difference in what has small curvature and panel board thickness of a face-plate according to such a problem.
[0004]
[Problem(s) to be Solved by the Invention] The purpose of this invention is to offer the curved surface where curvature is small, and the method of manufacturing the curved-surface sandwiches panel which has the complicated configuration from which panel height differs partially with a sufficient precision according to the high blowing pressure force.
[0005]
[Means for Solving the Problem] The manufacture approach of the curved-surface sandwiches panel concerning claim 1 of this invention In manufacture of the curved-surface sandwiches panel which consists of a face-plate [of both the outsides of the porous layer by which foaming formation was carried out as core material, and this porous layer] of two sheets of solid metal As primary processing, a metal powder and a foaming agent are put between the face-plates of solid metal of two sheets, Rolling plaiting is given to the obtained member, press working of sheet metal is performed for the member in which each class carried out metallic bond by this to a predetermined curved-surface configuration or a predetermined three-dimension configuration, and a laminated wood is obtained. After that as secondary

elaboration In case a foaming agent is made to foam and is fabricated by arranging a product configuration in ******** metal mold, and pressurizing the laminated wood by which press working of sheet metal was carried out, it is characterized by having sealed all panel edges.
[0006] The manufacture approach of the curved-surface sandwiches panel concerning claim 2 of this invention is characterized by sealing a panel edge by clamping a panel edge in a curved-surface sandwiches panel according to claim 1.
[0007] The manufacture approach of the curved-surface sandwiches panel concerning claim 3 of this invention is characterized by sealing a panel edge by welding extrusion material to a panel edge in a curved-surface sandwiches panel according to claim 1.
[0008] the curved-surface sandwiches panel concerning claim 4 of this invention -- claims 1-3 -- in the manufacture approach of a curved-surface sandwiches panel given [one of] in a term, it is characterized by changing the thickness of the mixolimnion of a metal powder and a foaming agent by controlling the welding pressure of rolling plaiting.
[0009] the manufacture approach of the curved-surface sandwiches panel concerning claim 5 of this invention -- claims 1-3 -- in the manufacture approach of a curved-surface sandwiches panel given [one of] in a term, it is characterized by changing the thickness of the mixolimnion after foaming by changing the foaming agent mixing percentage to a metal powder.
[0010]
[Embodiment of the Invention] A suitable example explains this invention to a detail, referring to a drawing. Drawing 2 is drawing showing one example of the manufacture approach of the curved-surface sandwiches panel of this invention. First, after mixing metal powder, for example, an aluminium powder, and TiH2 fine particles as foam to homogeneity, it extrudes to tabular [of 25mm thickness], and the foaming anterior part material a as core material is manufactured. After putting the foaming anterior part material a concerned with the aluminum plates b and c of 6063-T four with a thickness of 0.8mm, it presses down with a reduction roll and the laminate which consists of aluminum face-plates b1 and c1 with a thickness of 8mm and a core a1 is fabricated. Under the present circumstances, the part with the slack which a core a1 and face-plates b1 and c1 have not stuck to the perimeter of an edge of the face-plate of a laminate was prepared. This amount of slack is made into less than 10% to the rectangular cross lay length within a field of a product side, respectively. The edge of this laminate was extruded, and it inserted in the extrusion with a mold material of 15mm, for example, thickness, mold material d of aluminium alloy 6N01-T5, and was crowded, this extrusion mold material d and the face-plates b1 and c1 of a laminate were welded, and the foaming anterior part material a1 was sealed completely. Although laser welding can be suitably used for welding, it is not limited to this but a well-known welding process can be used.
[0011] It installed between the foaming molds f for obtaining the product configuration of a request of this foaming anterior part material a1, and the extrusion mold material d of aluminum containing alloy 6N01-T5 currently welded at the laminate edge was clamped with Mold e. Induction heating of the mold was carried out in this condition, and it heated at the temperature to which foaming anterior part material foams, for example, 610 degrees C, for 4 minutes. Thus, by being heated and foaming in the condition of having been sealed, the pressure in a laminate rose and the curved-surface sandwiches panel of a configuration which met the mold f of a product configuration side was fabricated.
[0012] In the above-mentioned suitable example, although slack was prepared in the face-plate of a laminate, when uniform elongation of the ingredient of x and **** is made into y % for this upper limit die length at an upper limit, if it is more than x/ (1+y/100), especially a limit will not be carried out in the die length of the product side corresponding to [amount / of slack / this] this in the die length of the field inboard of the arbitration of a face-plate.
[0013] Moreover, although aluminum containing alloy extrusion mold material was prepared in the edge of a laminate, it extruded so that the foaming anterior part material of a laminate might be sealed completely, and mold material and a face-plate were welded in this suitable example To join the panel after foaming to another member directly without extrusion material Full enclosure of the foaming anterior part material of a laminate may be carried out by inserting a spacer between the face-plates of a

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laminate and clamping a vertical face-plate with a mold instead of the sealing terminal treatment of the laminate by such extrusion mold material.

[0014] Next, drawing 3 explains other suitable examples of this invention. In manufacture of the foaming anterior part material a1 in the above-mentioned suitable example (drawing 2), although TiH2 foam was added 14% of the weight with what was added 7% of the weight, two kinds were manufactured here. Subsequently, this foaming anterior part material was inserted with 6063-T four and the board thickness =0.8mm vertical face-plates b1 and c1, and it pressed down with a roll. At this time, what made core material the foaming anterior part material a4 which added TiH2 foam 7% of the weight changed laminate thickness from 8mm to 15mm the middle by changing rolling reduction during pressing down with a roll. Thus, the made laminate is p. Moreover, the laminated wood q which sandwiched the foaming anterior part material from which the rate of foaming agent addition differs was obtained from the thing c3 which presupposed that rolling reduction is fixed in manufacture of a laminate, however added TiH2 for foaming anterior part material 7% on the way by cutting and replacing TiH2 with the thing a2 added 14% of the weight. Terminal sealing processing which shows this laminated wood in the above-mentioned suitable example (drawing 2) was performed, and it was made to insert, heat and foam in a foaming mold. The obtained curved-surface panel is with S and R respectively, and is a curved-surface panel which what sandwiched the material before foaming from which the rate of foaming agent addition differs, respectively, and the thickness of a laminate were changed from 8mm to 15mm the middle, and was obtained.

[0015] Thus, difference thickness-ization as a final product panel can be made easy by changing the rate of addition of a foaming agent by the panel part, or forming the laminate before foaming into difference thickness. moreover -- as a metal powder -- an aluminium powder -- moreover, although TiH2 powder was mentioned as a foaming agent, it limits to this -- not having -- as a metal powder -- milt etc. -- it can use -- as a foaming agent -- milt balun (S. B.) etc. -- it can also use. In addition, especially the board thickness of the vertical face-plate of a layered product is not restricted.

[0016]

[Effect of the Invention] According to the manufacture approach of the curved-surface sandwiches panel concerning claim 1 of this invention, or 2 According to the high blowing pressure force by making it seal between the face-plates of solid metal of two sheets The panel which has a complicated curved surface where two or more curved surfaces continue, or the panel which has a three-dimensions curved surface a product configuration by changing the configuration of ******** metal mold It can manufacture simply and with high precision, and it becomes possible to obtain the curved-surface sandwiches panel which has the porous layer by which foaming formation was carried out at the core material of high quality.

[0017] Since the extrusion material of the edge used the making it seal between the face-plates of solid metal of two sheets purpose can be made [according to the manufacture approach of the curved-surface sandwiches panel concerning claim 3 of this invention] to serve a double purpose as some final products in addition to the above-mentioned effectiveness consequently, a routing counter can be reduced and it becomes possible to raise productivity.

[0018] In addition to the above-mentioned effectiveness, by controlling the welding pressure of rolling plaiting, the inflow of the mixolimnion of a metal powder and a foaming agent can be controlled, it becomes possible to change the board thickness of the product configuration obtained partially after foaming, and, according to the manufacture approach of the curved-surface sandwiches panel concerning claim 4 of this invention, the panel of a desired complicated configuration is obtained.

[0019] According to the manufacture approach of the curved-surface sandwiches panel concerning claim 5 of this invention In the metal powder and foaming agent mixolimnion which were inserted between the face-plates of solid metal in addition to the above-mentioned effectiveness By making the member obtained by allotting that to which foaming agent mixing percentage was changed between the face-plates of solid metal foam, it becomes possible to change partially the board thickness and the consistency of a product configuration which are obtained, and the panel of a desired complicated configuration is obtained.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the process of the manufacture approach of the curved-surface sandwiches panel by the conventional approach.
[Drawing 2] It is drawing showing the process of the manufacture approach of the curved-surface sandwiches panel by this invention.
[Drawing 3] It is drawing showing the process of the manufacture approach of the difference thickness by this invention, and a different foam curved-surface foaming sandwiches panel.
[Description of Notations]
Front [foaming] material
b Aluminum plate
c Aluminum plate
a1 Core
b1 Face-plate
c1 Face-plate
d Extrusion mold material
e, e' mold
f Foaming mold
a4 Foaming anterior part material
a2 Foam: Foaming anterior part material which added TiH2 14% of the weight
a3 Foaming anterior part material which added TiH2 7% of the weight
a20, a30, and a40 Foaming member in the condition of having made it foaming
P Difference thickness laminate
q The laminate which sandwiched two kinds of foaming anterior part material, the foaming anterior part material which added TiH2 14% of the weight, and the foaming anterior part material which added TiH2 7% of the weight
R The panel in the condition of the difference thickness laminate having carried out foaming mold setting, and having made it foaming
S The panel in the condition of having made the laminate which sandwiched two kinds of foaming anterior part material, the foaming anterior part material which added TiH2 14% of the weight, and the foaming anterior part material which added TiH2 7% of the weight, putting in and foaming in a foaming mold

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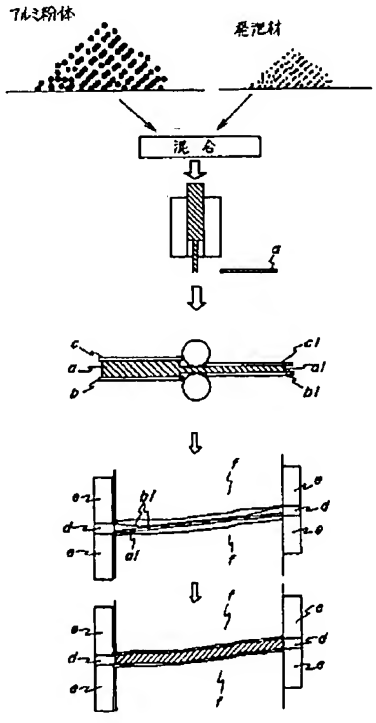
最終頁に続く

(54)【発明の名称】　曲面サンドウィッチパネルの製造方法

(57)【要約】
【課題】　高い発泡圧力により、曲率の小さな曲面や、パネル高さが部分的に異なる複雑な形状を有する曲面サンドウィッチパネルを、精度良く製造できる方法を提供する。
【解決手段】　曲面サンドウィッチパネルの製造方法は、コア材としての発泡形成された有孔性の層と、該有孔性の層の両外側の２枚の中実金属製の面板とからなる曲面サンドウィッチパネルの製造において、１次加工として、２枚の中実金属製の面板の間に金属粉と発泡剤とを挟み込み、得られた部材に圧延プレーティングを施し、これにより各層が金属結合した部材を所定の曲面形状又は３次元形状にプレス加工を施して、積層材を得、その後２次加工として、プレス加工された積層材を製品形状を型どった金型中に配置して加圧することにより発泡剤を発泡させて成形する際、パネル端部を全て密閉している。



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【特許請求の範囲】

【請求項１】　コア材としての発泡形成された有孔性の層と、該有孔性の層の両外側の２枚の中実金属製の面板とからなる曲面サンドウィッチパネルの製造において、１次加工として、２枚の中実金属製の面板の間に金属粉と発泡剤とを挟み込み、得られた部材に圧延プレーティングを施し、これにより各層が金属結合した部材を所定の曲面形状又は３次元形状にプレス加工を施して積層材を得、その後２次加工として、プレス加工された積層材を製品形状を型どった金型中に配置して加圧することにより発泡剤を発泡させて成形する際、パネル端部を全て密閉していることを特徴とする曲面サンドウィッチパネルの製造方法。

【請求項２】　請求項１記載の曲面サンドウィッチパネルの製造方法において、パネル端部をクランプすることによって、パネル端部の密閉を行なうことを特徴とする曲面サンドウィッチパネルの製造方法。

【請求項３】　請求項１記載の曲面サンドウィッチパネルの製造方法において、パネル端部に押出し材を溶接することによって、パネル端部の密閉を行なうことを特徴とする曲面サンドウィッチパネルの製造方法。

【請求項４】　請求項１～３いずれかの項記載の曲面サンドウィッチパネルの製造方法において、圧延プレーティングの加圧力を制御することにより、金属粉と発泡剤との混合層の厚みを変化させることを特徴とする曲面サンドウィッチパネルの製造方法。

【請求項５】　請求項１～４いずれかの項記載の曲面サンドウィッチパネルの製造方法において、金属粉に対する発泡剤混合率を変化させることにより、発泡後の混合層の厚みを変化させることを特徴とする曲面サンドウィッチパネルの製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、曲面サンドウィッチパネルの製造方法に関し、特に、コア材に発泡形成された有孔性の層を有する曲面サンドウィッチパネルの製造方法に関するものである。

【０００２】

【従来の技術】従来から曲面発泡サンドウィッチパネルの成形方法としては、代表的に図１に示すような方法が用いられている。かかる方法は、まずアルミニウム粉体と発泡剤粉体とを混合し、該混合粉体を押出し成形して、製品パネルのコア部に相当する形状に沿った素材ａに成形し、この素材ａをアルミ板ｂとｃとで挟持し、これをロールにて一体の板に成形する。次いで、面板ｂ１，ｃ１とコアａ１とからなる当該板をプレスで予備成形した後（図１中の最下流図）、製品形状を得るための発泡型に入れ、熱を加えてコアａ１を発泡させることにより、面板を型形状に沿った形状とする方法で、曲面発泡サンドウィッチパネルを製造するものである。

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【０００３】しかしながら、このような従来の曲面発泡サンドウィッチパネルの成形方法にあっては、発泡自体が自然発泡であるため、発泡による面板押上力が小さく、面板を製品曲面に沿った形状とするためには、面板自体を小さな成形力で変形し得る薄膜状にしなければならないという制約があった。また、この制約から、面板が薄膜状であるため、面板が少し延びたり又は局所的な変形を受けると、破断してしまうという問題があった。このような問題により、面板の曲率が小さいものや、パネル板厚に差があるものを製造するのは困難であった。

【０００４】

【発明が解決しようとする課題】本発明の目的は、高い発泡圧力により、曲率の小さな曲面や、パネル高さが部分的に異なる複雑な形状を有する曲面サンドウィッチパネルを、精度良く製造できる方法を提供することにある。

【０００５】

【課題を解決するための手段】本発明の請求項１にかかる曲面サンドウィッチパネルの製造方法は、コア材としての発泡形成された有孔性の層と、該有孔性の層の両外側の２枚の中実金属製の面板とからなる曲面サンドウィッチパネルの製造において、１次加工として、２枚の中実金属製の面板の間に金属粉と発泡剤とを挟み込み、得られた部材に圧延プレーティングを施し、これにより各層が金属結合した部材を所定の曲面形状又は３次元形状にプレス加工を施して積層材を得、その後２次加工として、プレス加工された積層材を製品形状を型どった金型中に配置して加圧することにより発泡剤を発泡させて成形する際、パネル端部を全て密閉していることを特徴とするものである。

【０００６】本発明の請求項２にかかる曲面サンドウィッチパネルの製造方法は、請求項１記載の曲面サンドウィッチパネルにおいて、パネル端部をクランプすることによって、パネル端部の密閉を行なうことを特徴とするものである。

【０００７】本発明の請求項３にかかる曲面サンドウィッチパネルの製造方法は、請求項１記載の曲面サンドウィッチパネルにおいて、パネル端部に押出し材を溶接することによって、パネル端部の密閉を行なうことを特徴とするものである。

【０００８】本発明の請求項４にかかる曲面サンドウィッチパネルは、請求項１～３いずれかの項記載の曲面サンドウィッチパネルの製造方法において、圧延プレーティングの加圧力を制御することにより、金属粉と発泡剤との混合層の厚みを変化させることを特徴とするものである。

【０００９】本発明の請求項５にかかる曲面サンドウィッチパネルの製造方法は、請求項１～３いずれかの項記載の曲面サンドウィッチパネルの製造方法において、金属粉に対する発泡剤混合率を変化させることにより、発

泡後の混合層の厚みを変化させることを特徴とするものである。

【００１０】

【発明の実施の形態】本発明を図面を参照しながら、好適例により詳細に説明する。図２は、本発明の曲面サンドウィッチパネルの製造方法の一実施例を示す図である。まず、金属粉末、例えばアルミニウム粉末と発泡材としてのTiH_2粉体とを均一に混合した後、例えば２５ｍｍ厚さの板状に押出して、コア材としての発泡前部材ａを製造する。当該発泡前部材ａを、厚さ０．８ｍｍの６０６３－Ｔ４のアルミニウム板ｂとｃとで挟み込んだ後、圧延ロールにて圧下し，厚さ８ｍｍの、アルミ面板ｂ１及びｃ１とコアａ１とからなる積層板を成形する。この際、積層板の面板の端部周囲にコアａ１と、面板ｂ１及びｃ１とが密着していない弛みのある部分を設けた。この弛み量は、製品面の面内直交方向の長さに対して、それぞれ１０％以内とする。この積層板の端部を押出し型材、例えば厚さ１５ｍｍのアルミニウム合金６Ｎ０１－Ｔ５の押出し型材ｄにはめこみ、この押出し型材ｄと積層板の面板ｂ１及びｃ１とを溶接し、発泡前部材ａ１を完全に密封した。溶接には、例えばレーザー溶接を好適に用いることができるが、これに限定されず公知の溶接方法を用いることができる。

【００１１】該発泡前部材ａ１を所望の製品形状を得るための発泡型ｆの間に設置し、積層板端部で溶接されているアルミ合金６Ｎ０１－Ｔ５の押出し型材ｄを型ｅでクランプした。この状態で型を誘導加熱し、発泡前部材が発泡する温度、例えば６１０℃で４分加熱した。このように密閉された状態で、加熱されて発泡することにより、積層板内の圧力は上昇し、製品形状面の型ｆに沿った形状の曲面サンドウィッチパネルが成形された。

【００１２】上記好適例では、積層板の面板に弛みを設けたが、この弛み量は、面板の任意の面内方向の長さが、これに対応した製品面の長さを上限に、この上限長さをｘ、画板の材料の均一伸びをｙ％とした時、ｘ÷（１＋ｙ／１００）以上であれば特に制限はされない。

【００１３】また、本好適例では積層板の端部にアルミ合金押出し型材を設け、積層板の発泡前部材を完全に密閉するように押出し型材と面板とを溶接したが、発泡成形後のパネルを押出し材を介さず直接、別部材と接合したい場合は、このような押出し型材による積層板の密閉端末処理の代わりに、積層板の面板間にスペーサを挿入し、上下面板を型でクランプすることにより、積層板の発泡前部材を完全封入してもかまわない。

【００１４】次に、本発明の他の好適例を、図３により説明する。上記好適例（図２）における発泡前部材ａ１の製造にあたり、ここでは、TiH_2発泡材を７重量％添加したものと、１４重量％添加したものの２種類を製造した。次いで、この発泡前部材を６０６３－Ｔ４、板厚＝０．８ｍｍの上下面板ｂ１とｃ１とで挟み、ロールで圧下した。この時、TiH_2発泡材を７重量％添加した発泡前部材ａ４をコア材としたものは、ロールで圧下中、圧下率を変化させることにより、積層板厚さを８ｍｍから途中１５ｍｍに変化させた。このようにしてできた積層板がｐである。また、積層板の製造において圧下率は一定とし、但し、途中で発泡前部材をTiH_2を７％添加したものｃ３から、TiH_2を１４重量％添加したものａ２に切り代えることにより、発泡剤添加率の異なる発泡前部材をサンドウィッチした積層材ｑを得た。この積層材を上記好適例（図２）で示す端末密閉処理を施し、発泡成形型に挿入して加熱し、発泡させた。得られた曲面パネルが各々ＳとＲとで、それぞれ、発泡剤添加率の異なる発泡前材をサンドウィッチしたものと、積層板の厚さを８ｍｍから途中１５ｍｍに変化させて得られた曲面パネルである。

【００１５】このように発泡剤の添加率をパネル部位により変化させ、または、発泡前の積層板を差厚化することにより、最終製品パネルとしての差厚化を容易にすることができる。また、金属粉としてアルミニウム粉末を、また発泡剤としてTiH_2粉末を挙げたが、これに限定されず金属粉としてシラス等を用いることができ、発泡剤としてはシラスバルーン（S.B.）等を用いることもできる。なお、積層体の上下面板の板厚は、特に制限されない。

【００１６】

【発明の効果】本発明の請求項１又は２にかかる曲面サンドウィッチパネルの製造方法によれば、２枚の中実金属製の面板間の密閉させることによる高い発泡圧力により、複数の曲面が連続するような複雑な曲面を有するパネル、あるいは三次元曲面を有するパネルでも、製品形状を型どった金型の形状を変化させてやることにより、簡単かつ高精度に製造でき、高品質のコア材に発泡形成された有孔性の層を有する曲面サンドウィッチパネルを得ることが可能になる。

【００１７】本発明の請求項３にかかる曲面サンドウィッチパネルの製造方法によれば、上記効果に加えて、２枚の中実金属製の面板間の密閉させる目的で用いる端部の押出し材を最終製品の一部として兼用することができるため、その結果、工程数を減じることができ、生産性を向上させることが可能になる。

【００１８】本発明の請求項４にかかる曲面サンドウィッチパネルの製造方法によれば、上記効果に加えて、圧延プレーティングの加圧力を制御することにより、金属粉と発泡剤の混合層の流入を制御することができ、発泡後、得られる製品形状の板厚を部分的に変化させることが可能となり、所望の複雑形状のパネルが得られる。

【００１９】本発明の請求項５にかかる曲面サンドウィッチパネルの製造方法によれば、上記効果に加えて、中実金属製の面板の間に挟まれた金属粉と発泡剤混合層において、発泡剤混合率を変化させたものを中実金属製の

面板の間に配することによって得られた部材を発泡させることにより、得られる製品形状の板厚及び密度を部分的に変化させることが可能となり、所望の複雑形状のパネルが得られる。

【図面の簡単な説明】

【図１】従来方法による曲面サンドウィッチパネルの製造方法の工程を示す図である。

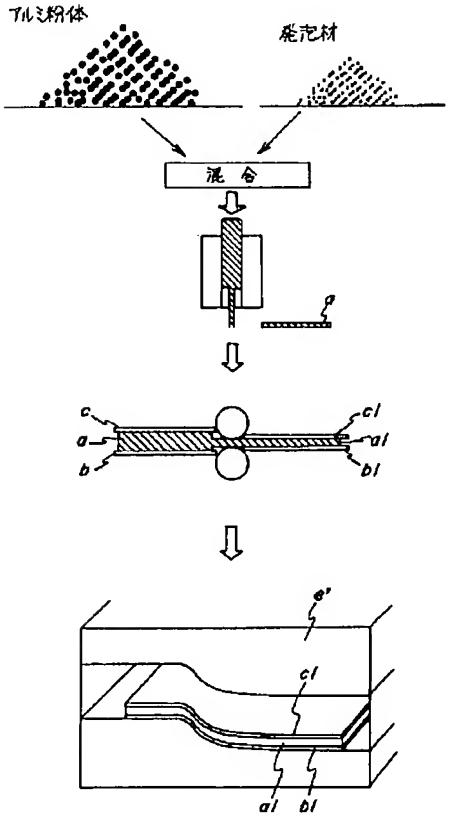
【図２】本発明による曲面サンドウィッチパネルの製造方法の工程を示す図である。

【図３】本発明による差厚及び異発泡材曲面発泡サンドウィッチパネルの製造方法の工程を示す図である。

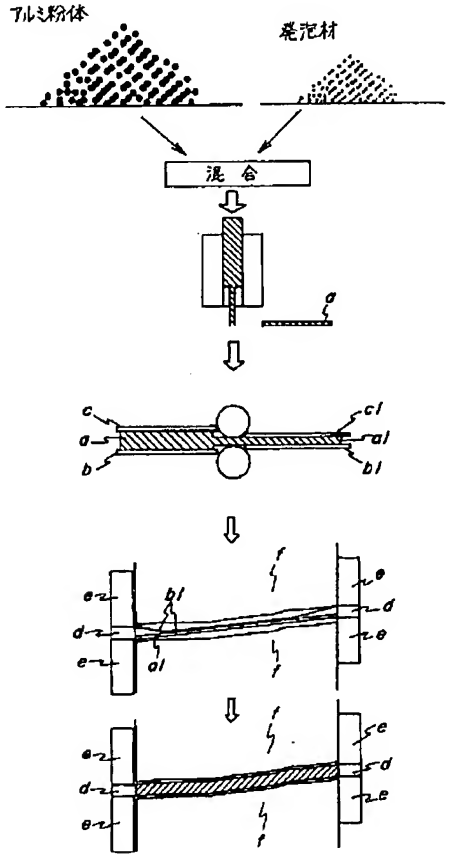
【符号の説明】

a　発泡前材
b　アルミ板
c　アルミ板
a1　コア
b1　面板
c1　面板
d　押出し型材
e, e´ 型
f　発泡型
a4　発泡前部材
a2　発泡材：TiH_2を１４重量%添加した発泡前部材
a3　TiH_2を７重量%添加した発泡前部材
a20, a30, a40 発泡させた状態の発泡部材
P　差厚積層板
q　TiH_2を１４重量%添加した発泡前部材とTiH_2を７重量%添加した発泡前部材の２種類の発泡前部材をサンドウィッチした積層板
R　差厚積層板の発泡型セッテイングし、発泡させた状態のパネル
S　TiH_2を１４重量%添加した発泡前部材とTiH_2を７重量%添加した発泡前部材の２種類の発泡前部材をサンドウィッチした積層板を発泡型に入れ、発泡させた状態のパネル

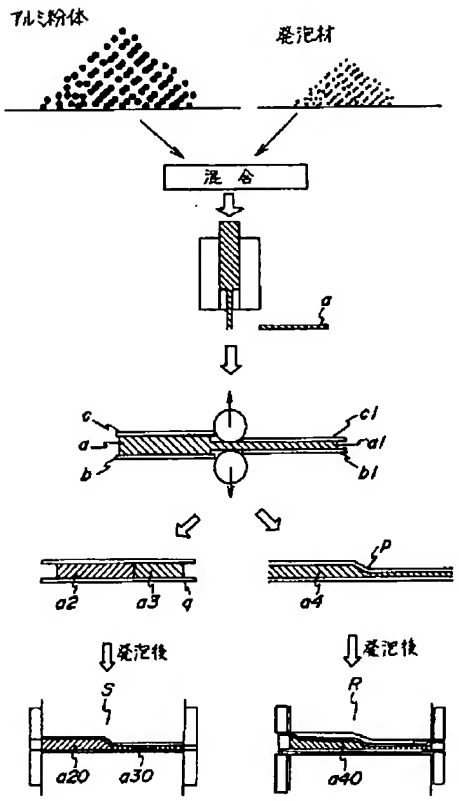
【図1】



【図2】



【図３】



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